BACKGROUND AND OBJECTIVES

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1.1 Introduction

Variations in seasonal weather patterns are as much a feature of the modern world as they were in historical times and the effects of such variability are manifest across a range of natural systems and human activities. Until recently, these variations have been assumed to represent natural fluctuations about an essentially stable average climate. However, the observation that concentrations of certain trace gases in the atmosphere have been increasing rapidly, primarily as a result of human activities, has led to the realisation that changes in atmospheric composition are capable of affecting the surface climate of the earth.

The trace gases, especially carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide, have the property of permitting the fairly free passage of short wavelength solar radiation from the sun through to the earth's surface, but absorbing the re-radiated radiation (at lower temperatures and longer wavelengths) from the earth. With the exception of CFCs, which are human-made, the natural occurrence of these gases in the atmosphere (along with water vapour, another strong absorber of terrestrial radiation) has maintained the earth's surface at an average temperature some 33°C higher than would be the case in their absence. Analogous to the effect of glass in a greenhouse, this mechanism has become known as the 'greenhouse effect', and the gases as greenhouse gases (GHGs).

Observed increases in GHG concentrations are thought to be altering the radiation balance of the earth, warming the surface and affecting the atmospheric circulation. It is this anticipated global warming of climate, the 'enhanced greenhouse effect', that has recently become the subject of great concern both locally and internationally. At a global scale, the rate and magnitude of predicted changes in climate are unprecedented in historical times, thus raising the question of their likely effects on physical processes, natural ecosystems and human activities and what, if any, measures there are for preventing or mitigating the more serious impacts.

1.2 Origins of this Report

In an attempt to clarify the issues and to identify the possible policy implications of the enhanced greenhouse effect at international level, the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC was charged with assessing the scientific information relating to three aspects of the climate change issue:

- Changes in climate arising from increasing greenhouse gas concentrations in the atmosphere.
- The environmental and socio-economic consequences of climate change.
- The formulation of response strategies.

These three tasks were assigned respectively to three Working Groups: I, II and III.

The IPCC published its First Assessment Report in 1990. One component of this, The IPCC Impacts Assessment, was contributed by Working Group II (IPCC, 1990b). The IPCC agreed to continue its work within a long term framework, and entered a new phase, using the First Assessment Report as the starting point.

In August 1991, Working Group II, in its Fourth Plenary, agreed to establish an expert group to develop some guidelines for the assessment of impacts of climate change. A summary of those deliberations forms part of the Working Group II contribution to the IPCC 1992 Supplement (IPCC 1992b). The full version of the guidelines document was published in 1992 as Preliminary Guidelines for Assessing Impacts of Climate Change (Carter *et al.*, 1992).

As part of its Second Assessment Report, IPCC Working Group II agreed to expand and revise the guidelines. This report is the product of that work.

1.3 General Objectives of Climate Impact Assessment

Climate impact assessment is a sequential set of activities designed to identify, analyse and evaluate the impacts of climate variability and climate change on natural systems, human activities and human health and well-being, to estimate the uncertainties surrounding these impacts, and to examine the possible adaptive responses for reducing adverse effects or exploiting new opportunities.

Climate impact assessment has two general objectives:

- To assess climate change impacts and adaptations in a scientific manner.
- To provide a mode of analysis that will enable policy makers and decision makers to choose among a set of adaptation options and develop a suitable mixed strategy of response that combines adaptation and mitigation measures, as appropriate.

The general responsibility of science is to expand the knowledge base for the common benefit. This should be achieved by developing the research methodology for assessment, collecting information on trends in the environment and in society, developing predictive tools for evaluating impacts, forging scientific links across disciplinary, institutional and political boundaries and communicating results objectively to other scientists, decision makers and the public.

Policy makers require climate impact assessments to provide them with the necessary scientific information for policy decisions. These decisions include considering the options for mitigating climatic change and/or those for adapting to it, either by coping with, mitigating or exploiting its projected impacts. Assessments are required for different time and space scales, reflecting the time horizons and areas to which planning and decision-making apply. They could also provide a basis for negotiating global and transnational protocols for addressing climatic change issues, which lie outside the jurisdiction of individual policy makers.

Climate impact assessment must address an inherently global phenomenon affecting all nations, so it is desirable that assessments be conducted in a transparent manner, with comparable assumptions and internally consistent procedures. Comparability among assessments is of great importance in appraising the range of appropriate response actions at the international, national and regional levels. Decision makers must have confidence that, at a minimum, the basic assumptions are uniform (e.g., use of a

common set of scenarios), that the various models and analytical tools are used correctly, and that the evaluation of impacts properly takes into account future impacts due to socio-economic and technological changes that would occur even in the absence of climate change.

1.4 *Purpose and Scope of the Report*

This report provides a review of the methods of climate impact and adaptation assessment. It is primarily oriented to the technical analyst responsible for organizing and undertaking a complex series of interrelated tasks. However, the methodology it adopts is itself designed to provide information for policy makers that is scientifically credible and useful for assisting in decision-making under uncertainty.

The term 'climate impact assessment' is used hereafter to refer to assessments both of the impacts of climatic variability and change and of possible adaptations to these. The report outlines a basic framework for the study of climate-environment-society interactions, with a particular emphasis on assessing the impacts of possible future changes in climate due to the enhanced greenhouse effect. Experience with assessing the social and economic impacts of climatic change is at present limited, while generalized methods for evaluating adaptation strategies for changing climate do not yet exist. Thus, these guidelines represent an early effort at formalizing some of these methods into workable procedures, and are amenable to refinement and development in future years.

The report does not aim to prescribe a single preferred method, but provides an analytical framework that comprises seven steps. A range of methods is identified at each step. Where possible the merits and drawbacks of different methods are discussed briefly, with some suggestions on their selection and use. Guidance is also offered on the organization of research and the communication of results.